



Last painting by Gilbert Stuart (1828). Considered by the family of Bowditch to be the best of various paintings made, although it was unfinished when the artist died.

NATHANIEL BOWDITCH

(1773-1838)

Nathaniel Bowditch was born on March 26, 1773, in Salem, Mass., fourth of the seven children of shipmaster Habakkuk Bowditch and his wife, Mary.

Since the migration of William Bowditch from England to the Colonies in the 17th century, the family had resided at Salem. Most of its sons, like those of other families in this New England seaport, had gone to sea, and many of them became shipmasters. Nathaniel Bowditch himself sailed as master on his last voyage, and two of his brothers met untimely deaths while pursuing careers at sea.

Nathaniel Bowditch's father is said to have lost two ships at sea, and by late Revolutionary days he returned to the trade of cooper, which he had learned in his youth. This provided insufficient income to properly supply the needs of his growing family, who were often hungry and cold. For many years the nearly destitute family received an annual grant of 15 to 20 dollars from the Salem Marine Society. By the time Nathaniel had reached the age of 10, the family's poverty forced him to leave school and join his father in the cooper's trade to help support the family.

Nathaniel was unsuccessful as a cooper, and when he was about 12 years of age, he entered the first of two ship-chandlery firms by which he was employed. It was during the nearly 10 years he was so employed that his great mind first attracted public attention. From the time he began school Bowditch had an all-consuming interest in learning, particularly mathematics. By his middle teens he was recognized in Salem as an authority on that subject. Salem being primarily a shipping town, most of the inhabitants sooner or later found their way to the ship chandler, and news of the brilliant young clerk spread until eventually it came to the attention of the learned men of his day. Impressed by his desire to educate himself, they supplied him with books that he might learn of the discoveries of other men. Since many of the best books were written by Europeans, Bowditch first taught himself their languages. French, Spanish, Latin, Greek and German were among the two dozen or more languages and dialects he studied during his life. At the age of 16 he began the study of Newton's *Principia*, translating parts of it from the Latin. He even found an error in that classic text, and though lacking the confidence to announce it at the time, he later published his findings and had them accepted by the scientific community.

During the Revolutionary War a privateer out of Beverly, a neighboring town to Salem, had taken as one of its prizes an English vessel which was carrying the philosophical library of a famed Irish scholar, Dr. Richard Kirwan. The books were brought to the Colonies and there bought by a group of educated Salem men who used them to found the

Philosophical Library Company, reputed to have been the best library north of Philadelphia at the time. In 1791, when Bowditch was 18, two Harvard-educated ministers, Rev. John Prince and Rev. William Bentley, persuaded the Company to allow Bowditch the use of its library. Encouraged by these two men and a third, Nathan Read, an apothecary and also a Harvard man, Bowditch studied the works of the great men who had preceded him, especially the mathematicians and the astronomers. By the time he became of age, this knowledge, acquired when not working long hours at the chandlery, had made young Nathaniel the outstanding mathematician in the Commonwealth, and perhaps in the country.

In the seafaring town of Salem, Bowditch was drawn to navigation early, learning the subject at the age of 13 from an old British sailor. A year later he began studying surveying, and in 1794 he assisted in a survey of the town. At 15 he devised an almanac reputed to have been of great accuracy. His other youthful accomplishments included the construction of a crude barometer and a sundial.

When Bowditch went to sea at the age of 21, it was as captain's writer and nominal second mate, the officer's berth being offered him because of his reputation as a scholar. Under Captain Henry Prince, the ship *Henry* sailed from Salem in the winter of 1795 on what was to be a year-long voyage to the Ile de Bourbon (now called Reunion) in the Indian Ocean.

Bowditch began his seagoing career when accurate time was not available to the average naval or merchant ship. A reliable marine chronometer had been invented some 60 years before, but the prohibitive cost, plus the long voyages without opportunity to check the error of the timepiece, made the large investment an impractical one. A system of determining longitude by "lunar distance," a method which did not require an accurate timepiece, was known, but this product of the minds of mathematicians and astronomers was so involved as to be beyond the capabilities of the uneducated seamen of that day. Consequently, ships were navigated by a combination of dead reckoning and parallel sailing (a system of sailing north or south to the latitude of the destination and then east or west to the destination). The navigational routine of the time was "lead, log, and lookout."

To Bowditch, the mathematical genius, computation of lunar distances was no mystery, of course, but he recognized the need for an easier method of working them in order to navigate ships more safely and efficiently. Through analysis and observation, he derived a new and simplified formula during his first trip.

John Hamilton Moore's *The Practical Navigator* was the leading navigational text when Bowditch first went to sea, and had been for many years. Early in his first voyage,

however, the captain's writer-second mate began turning up errors in Moore's book, and before long he found it necessary to recompute some of the tables he most often used in working his sights. Bowditch recorded the errors he found, and by the end of his second voyage, made in the higher capacity of supercargo, the news of his findings in *The New Practical Navigator* had reached Edmund Blunt, a printer at Newburyport, Mass. At Blunt's request, Bowditch agreed to participate with other learned men in the preparation of an American edition of the thirteenth (1798) edition of Moore's work. The first American edition was published at Newburyport by Blunt in 1799. This edition corrected many of the errors that Moore had included.

Although most of the errors were of little significance to practical navigation because they were errors in the fifth and sixth places of logarithm tables, some errors were significant. The most significant mistake was listing the year 1800 as a leap year in the table of the sun's declination. The consequence was that Moore gave the declination for March 1, 1800, as $7^{\circ}11'$. Since the actual value was $7^{\circ}33'$, the calculation of a meridian altitude would be in error by 22 minutes of latitude, or 22 nautical miles.

Bowditch's principal contribution to the first American edition was his chapter "The Method of Finding the Longitude at Sea," which discussed his new method for computing lunar distances. Following publication of the first American edition, Blunt obtained Bowditch's services in checking the American and English editions for further errors. Blunt then published a second American edition of Moore's thirteenth edition in 1800. When preparing a third American edition for the press, Blunt decided that Bowditch had revised Moore's work to such an extent that Bowditch should be named as author. The title was changed to *The New American Practical Navigator* and the book was published in 1802 as a first edition. Bowditch vowed while writing this edition to "put down in the book nothing I can't teach the crew," and it is said that every member of his crew including the cook could take a lunar observation and plot the ship's position.

Bowditch made a total of five trips to sea, over a period of about nine years, his last as master and part owner of the three-masted *Putnam*. Homeward bound from a 13-month voyage to Sumatra and the Ile de France (now called Mauritius) the *Putnam* approached Salem harbor on December 25, 1803, during a thick fog without having had a celestial observation since noon on the 24th. Relying upon his dead reckoning, Bowditch coned his wooden-hulled ship to the entrance of the rocky harbor, where he had the good fortune to get a momentary glimpse of Eastern Point, Cape Ann, enough to confirm his position. The *Putnam* proceeded in, past such hazards as "Bowditch's Ledge" (named after a great-grandfather who had wrecked his ship on the rock more than a century before) and anchored safely at 1900 that evening. Word of the daring

feat, performed when other masters were hove-to outside the harbor, spread along the coast and added greatly to Bowditch's reputation. He was, indeed, the "practical navigator."

His standing as a mathematician and successful shipmaster earned him a well-paid position ashore within a matter of weeks after his last voyage. He was installed as president of a Salem fire and marine insurance company at the age of 30, and during the 20 years he held that position the company prospered. In 1823 he left Salem to take a similar position with a Boston insurance firm, serving that company with equal success until his death.

From the time he finished the "*Navigator*" until 1814, Bowditch's mathematical and scientific pursuits consisted of studies and papers on the orbits of comets, applications of Napier's rules, magnetic variation, eclipses, calculations on tides, and the charting of Salem harbor. In that year, however, he turned to what he considered the greatest work of his life, the translation into English of *Mecanique Celeste*, by Pierre Laplace. *Mecanique Celeste* was a summary of all the then known facts about the workings of the heavens. Bowditch translated four of the five volumes before his death, and published them at his own expense. He gave many formula derivations which Laplace had not shown, and also included further discoveries following the time of publication. His work made this information available to American astronomers and enabled them to pursue their studies on the basis of that which was already known. Continuing his style of writing for the learner, Bowditch presented his English version of *Mecanique Celeste* in such a manner that the student of mathematics could easily trace the steps involved in reaching the most complicated conclusions.

Shortly after the publication of *The New American Practical Navigator*, Harvard College honored its author with the presentation of the honorary degree of Master of Arts, and in 1816 the college made him an honorary Doctor of Laws. From the time the Harvard graduates of Salem first assisted him in his studies, Bowditch had a great interest in that college, and in 1810 he was elected one of its Overseers, a position he held until 1826, when he was elected to the Corporation. During 1826-27 he was the leader of a small group of men who saved the school from financial disaster by forcing necessary economies on the college's reluctant president. At one time Bowditch was offered a Professorship in Mathematics at Harvard but this, as well as similar offers from West Point and the University of Virginia, he declined. In all his life he was never known to have made a public speech or to have addressed any large group of people.

Many other honors came to Bowditch in recognition of his astronomical, mathematical, and marine accomplishments. He became a member of the American Academy of Arts and Sciences, the East India Marine Society, the Royal Academy of Edinburgh, the Royal Society of London, the Royal Irish Academy, the American Philosophical Society, the Connecticut Academy of Arts

and Sciences, the Boston Marine Society, the Royal Astronomical Society, the Palermo Academy of Science, and the Royal Academy of Berlin.

Nathaniel Bowditch outlived all of his brothers and sisters by nearly 30 years. He died on March 16, 1838, in his sixty-fifth year. The following eulogy by the Salem Marine Society indicates the regard in which this distinguished American was held by his contemporaries:

“In his death a public, a national, a human benefactor has departed. Not this community, nor our country only, but the

whole world, has reason to do honor to his memory. When the voice of Eulogy shall be still, when the tear of Sorrow shall cease to flow, no monument will be needed to keep alive his memory among men; but as long as ships shall sail, the needle point to the north, and the stars go through their wonted courses in the heavens, the name of Dr. Bowditch will be revered as of one who helped his fellow-men in a time of need, who was and is a guide to them over the pathless ocean, and of one who forwarded the great interests of mankind.”

**THE NEW AMERICAN
PRACTICAL NAVIGATOR;
BEING AN
EPITOME OF NAVIGATION;
CONTAINING ALL THE TABLES NECESSARY TO BE USED WITH THE
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IN DETERMINING THE
LATITUDE;
AND THE
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AND
KEEPING A COMPLETE RECKONING AT SEA:**

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ALSO
MANY THOUSAND ERRORS ARE CORRECTED,
WHICH HAVE APPEARED IN THE BEST SYSTEMS OF NAVIGATION YET PUBLISHED.

BY **NATHANIEL BOWDITCH,**
FELLOW OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES.

ILLUSTRATED WITH COPPERPLATES.

First Edition.

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EDMUND M. BLUNT, (Proprietor)

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AND BY FIFTY BOOKSELLERS, STATIONERS, AND MATHEMATICAL INSTRUMENTMAKERS,
IN THE UNITED STATES AND WEST INDIES.

PREFACE

The Naval Observatory library in Washington, D.C., is unnaturally quiet. It is a large circular room, filled with thousands of books. Its acoustics are perfect; a mere whisper from the room's open circular balcony can be easily heard by those standing on the ground floor. A fountain in the center of the ground floor softly breaks the room's silence as its water stream gently splashes into a small pool. From this serene room, a library clerk will lead you into an antechamber, beyond which is a vault containing the Observatory's most rare books. In this vault, one can find an original 1802 first edition of the *New American Practical Navigator*.

One cannot hold this small, delicate, slipcovered book without being impressed by the nearly 200-year unbroken chain of publication that it has enjoyed. It sailed on U.S. merchantmen and Navy ships shortly after the quasi-war with France and during British impressment of merchant seamen that led to the War of 1812. It sailed on U.S. Naval vessels during operations against Mexico in the 1840's, on ships of both the Union and Confederate fleets during the Civil War, and with the U.S. Navy in Cuba in 1898. It went around the world with the Great White Fleet, across the North Atlantic to Europe during both World Wars, to Asia during the Korean and Vietnam Wars, and to the Middle East during Operation Desert Storm. It has circled the globe with countless thousands of merchant ships for 200 years.

As navigational requirements and procedures have changed throughout the years, *Bowditch* has changed with them. Originally devoted almost exclusively to celestial navigation, it now also covers a host of modern topics. It is as practical today as it was when Nathaniel Bowditch, master of the *Putnam*, gathered the crew on deck and taught them the mathematics involved in calculating lunar distances. It is that practicality that has been the publication's greatest strength, and that makes the publication as useful today as it was in the age of sail.

Seafarers have long memories. In no other profession is tradition more closely guarded. Even the oldest and most cynical acknowledge the special bond that connects those who have made their livelihood plying the sea. This bond is not comprised of a single strand; rather, it is a rich and varied tapestry that stretches from the present back to the birth of our nation and its seafaring culture. As this book is a part of that tapestry, it should not be lightly regarded; rather, it should be preserved, as much for its historical importance as for its practical utility.

Since antiquity, mariners have gathered available navigation information and put it into a text for others to follow. One of the first attempts at this involved volumes of

Spanish and Portuguese navigational manuals translated into English between about 1550 to 1750. Writers and translators of the time "borrowed" freely in compiling navigational texts, a practice which continues today with works such as *Sailing Directions and Pilots*.

Colonial and early American navigators depended exclusively on English navigation texts because there were no American editions. The first American navigational text, *Orthodoxal Navigation*, was completed by Benjamin Hubbard in 1656. The first American navigation text published in America was Captain Thomas Truxton's *Remarks, Instructions, and Examples Relating to the Latitude and Longitude; also the Variation of the Compass, Etc., Etc.*, published in 1794.

The most popular navigational text of the late 18th century was John Hamilton Moore's *The New Practical Navigator*. Edmund M. Blunt, a Newburyport publisher, decided to issue a revised copy of this work for American navigators. Blunt convinced Nathaniel Bowditch, a locally famous mariner and mathematician, to revise and update *The New Practical Navigator*. Several other learned men assisted in this revision. Blunt's *The New Practical Navigator* was published in 1799. Blunt also published a second American edition of Moore's book in 1800.

By 1802, when Blunt was ready to publish a third edition, Nathaniel Bowditch and others had corrected so many errors in Moore's work that Blunt decided to issue the work as a first edition of the *New American Practical Navigator*. It is to that 1802 work that the current edition of the *American Practical Navigator* traces its pedigree.

The *New American Practical Navigator* stayed in the Bowditch and Blunt family until the government bought the copyright in 1867. Edmund M. Blunt published the book until 1833; upon his retirement, his sons, Edmund and George, took over publication. The elder Blunt died in 1862; his son Edmund followed in 1866. The next year, 1867, George Blunt sold the copyright to the government for \$25,000. The government has published *Bowditch* ever since. George Blunt died in 1878.

Nathaniel Bowditch continued to correct and revise the book until his death in 1838. Upon his death, the editorial responsibility for the *American Practical Navigator* passed to his son, J. Ingersoll Bowditch. Ingersoll Bowditch continued editing the *Navigator* until George Blunt sold the copyright to the government. He outlived all of the principals involved in publishing and editing the *Navigator*, dying in 1889.

The U.S. government has published some 52 editions since acquiring the copyright to the book that has come to

be known simply by its original author's name, "*Bowditch*." Since the government began production, the book has been known by its year of publishing, instead of by the edition number. During a revision in 1880 by Commander Phillip H. Cooper, USN, the name was changed to *American Practical Navigator*. Bowditch's original method of taking "lunars" was finally dropped from the book just after the turn of the 20th century. After several more revisions and printings through World Wars I and II, *Bowditch* was extensively revised for the 1958 edition and again in 1995.

Recognizing the limitations of the printed word, and that computers and electronic media permit us to think about the processes of both navigation and publishing in completely new ways, NIMA has, for the 2002 edition, produced the first official Compact Disk-Read Only Memory (CD-ROM) version of this work. This CD contains, in addition to the full text of the printed book, electronic enhancements and additions not possible in book form. Our goal is to put as much useful navigational information before the navigator as possible in the most understandable and readable format. We are only beginning to explore the possibilities of new technology in this area.

As much as it is a part of history, *Bowditch* is not a history book. As in past editions, dated material has been dropped and new methods, technologies and techniques added to keep pace with the rapidly changing world of navigation. The changes to this edition are intended to ensure that it remains the premier reference work for modern, practical marine navigation. This edition replaces but does not cancel former editions, which may be retained and consulted as to historical navigation methods not discussed herein.

PART 1, FUNDAMENTALS, includes an overview of the types and phases of marine navigation and the organizations which develop, support and regulate it. It includes chapters relating to the types, structure, use and limitations of nautical charts; a concise explanation of geodesy and chart datums; and a summary of various necessary navigational publications.

PART 2, PILOTING, emphasizes the practical aspects of navigating a vessel in restricted waters, using both traditional and electronic methods.

PART 3, ELECTRONIC NAVIGATION, explains the nature of radio waves and electronic navigation systems. Chapters deal with each of the several electronic methods of navigation--satellite, Loran C, and radar, with special emphasis on satellite navigation systems and electronic charts.

PART 4, CELESTIAL NAVIGATION, updates the former edition with more modern terminology, and discusses

the use of calculators and computers for the solution of celestial navigation problems.

PART 5, NAVIGATIONAL MATHEMATICS, remains unchanged from the former edition.

PART 6, NAVIGATIONAL SAFETY, discusses recent developments in management of navigational resources, the changing role of the navigator, distress and safety communications, procedures for emergency navigation, and the increasingly complex web of navigation regulations.

PART 7, OCEANOGRAPHY, has been updated to reflect the latest science and terminology.

PART 8, MARINE WEATHER incorporates updated weather routing information and new cloud graphics.

The pronoun "he," used throughout this book as a reference to the navigator, refers to both genders.

The printed version of this volume may be corrected using the Notice to Mariners and Summary of Corrections. Suggestions and comments for changes and additions may be sent to:

NATIONAL IMAGERY AND MAPPING AGENCY
MARITIME SAFETY INFORMATION DIVISION
MAIL STOP D-44
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This book could not have been produced without the expertise of dedicated personnel from many government organizations, among them: U.S. Coast Guard, U.S. Naval Academy, U.S. Naval Oceanographic Office, US Navy Fleet Training Center, the U.S. Naval Observatory, Office of the Navigator of the Navy, U.S. Merchant Marine Academy, U.S. Coast and Geodetic Survey, the National Ocean Service, and the National Weather Service. In addition to official government expertise, we must note the contributions of private organizations and individuals far too numerous to mention. Mariners worldwide can be grateful for the experience, dedication, and professionalism of the many people who generously gave their time in this effort. A complete list of contributors can be found in the "Contributor's Corner" of the CD-ROM version of this book.

THE EDITORS